Late talkers in Cantonese: The productive language outcome and the relationship between phonetic development and lexicon size

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ABSTRACT

The phonetic development of 33 late talkers, identified at 15 to 20 months via the Cantonese Communicative Development Inventory, a parent report instrument was investigated at one-year follow up. The relationship of lexicon size with phonetic development was also examined. The late talkers were found at follow-up to have a smaller phonetic inventory size, lower accuracy of production and demonstrate phonetic development delay. Strong correlation of the two variables was noted only at the early stage of lexical and phonetic development.

Prognosis of the late talkers in lexical development and its predictors were also explored in 55 late talkers in the same age range as above. Results indicated that less than half of the late talkers would catch up, even though some of them showed improvement. Age of first word and expressive vocabulary size at intake were found to be non-significant predictors of the productive lexical development of the late talkers. The implications of the above findings on diagnosis and remediation are discussed.

INTRODUCTION

Toddlers who demonstrate restricted expressive language abilities, in terms of reduced vocabulary size and delayed onset of word combination, without any deficits in hearing, intelligence and receptive language ability, have raised much interests among researchers. This group of toddlers has been labeled as "late talkers" (Rescorla, Ratner & Pharr, 2000). Late talkers have been identified on the basis of their early-restricted expressive language abilities. There are different ways to identify late talkers in the published literature. Rescorla and Schwartz (1990) have identified late talkers as children who had less than 50 productive words or no word combination by age 2 based on the parent checklist: Language Development Survey (LDS). Paul (1991) has considered toddlers as late talkers if they produced fewer than 10 intelligible words at 18-23 month-old or if they used less than 50 words or had no two-word combination at 24-34 month-old based on LDS. Thal and his colleagues (1997) have identified toddlers as late talkers if they produced no two-word combination and scored in the lowest 10^{th} percentile for expressive vocabulary for their age, based on the parental report.

Approximately 10% to 14% of children have been identified as later talkers by LDS (Paul & Jennings, 1992). However, the underlying deficit of the expressive language impairment of the late talkers has not yet been determined (Rescorla & Ratner, 1996). Curtiss and Tallal (1991) claim that the child's information processing ability pose a constraint on his expressive language development. Johnston (1985) and Kirchner and Klatzky (1985) attribute the deficit to the limitation of memory capacity and symbolic capacity respectively (cited in Rescorla & Ratner, 1996). Stoel-Gammon (1989) has proposed that phonological development might be a limiting factor for the late talkers' lexical development.

In fact, a number of studies have explored the link between phonology and lexicon production in the early stage of language acquisition for normally developing children (Thal, Oroz & McCaw, 1995). For example, Stoel-Gammon (1991) found a strong correlation between the phonetic inventory size and the lexicon size in normal 2-years-old toddlers. She indicated

that children with relatively fewer sounds had smaller vocabularies and vice versa. Researchers believe that it is also the case for late talkers. Paul and Jennings (1992) found a fewer complex syllable structures, fewer different consonants and lower percentage of consonants correct in their late talkers' productions than their normal age-matched peers. Thus, they suggest a link between expressive language delay and immature phonetic development of the late talkers. Also, the study of Vihman and McCune (2001) found an identical distribution of consonants and syllable structures of late talkers' first words to their babbles' patterns. It further suggests that the lexical development and phonological development is somewhat related in late talkers.

However, the direction and the nature of link between lexical and phonetic development have not yet been clearly established. There are three kinds of proposals for the direction and nature of the link. First of all, lexical development influences phonological acquisition (Girolametto, Pearce & Weitzman, 1997). It was found that the phonological diversity (syllable structure level and consonant inventory) of the late talkers could be improved by increasing their exposure to vocabulary. This claim is supported by the interactionist-discovery theory (Menn, 1980, cited in Girolametto et al., 1997). It states that children discover the rules of phonology through lexical learning and the exposure to a rich language environment.

The second proposal is the opposite of the first one: phonetic inventory influences acquisition of new words. Storkel and Morrisette (2002) found that infants produced novel words composed of sounds that were in their phonetic inventory more frequently than those of sounds that were out of their phonetic inventory. It could be explained by a concept termed "Vocal Motor Scheme" (Vihman & McCune, 2001). It states that the more frequent a child produces the movements that shape the vocal tract to produce a certain sound, the more automatic this vocal movement is and hence the easier the child is to produce a word of that sound.

The most common and conservative claim is the third proposal: the bi-directional relationship of lexical and phonetic development. Many studies (Stoel-Gammon, 1989; Paul &

Jennings, 1992; Locke, 1994) suggest that limited phonetic inventory size might limit the child's ability to attempt words and on the other hand, restricted lexicon size might provide little chance for the child to practice speech articulation skills. A two-representation connectionist model of spoken word processing is put forward to support this claim. The model depicts two types of mental representations, lexical and phonological, and there are facilitory connections between the lexical and phonological representations. Once the lexical representation is activated, its corresponding phonological representation will also be activated and vice versa (Storkel & Morrisette, 2002).

Regardless of what the relationship between lexical and phonetic size is, a large body of literature shows that late talkers are phonologically less advanced than their normally developing age-mates (Paul & Jennings, 1992; Stoel-Gammon, 1991). Stoel-Gammon (1989) tracked the phonetic development of two late talkers and a group of normally developing children from 9 to 24 month-old. Observable differences were seen between the two groups. At 9 month-old, one of the late talkers showed a restricted babble inventory while the other' s babbling reflected unusual sound preferences. At 24 month-old, both of them displayed limited phonetic inventory and simpler syllable shapes in speech. Paul and Jennings (1992) also did a similar study with a larger sample of late talkers. They compared the phonological behavior of 28 late talkers with that of 25 normally developing age-matched toddlers. The late talkers were found to have restricted phonetic inventories, simpler syllable shapes and reduced accuracy of production. In addition, the result indicated that the phonetic development of the late talkers was delayed rather than deviant. Similar findings have also been reported in the studies of Thal, et al. (1995) and Rescorla & Ratner (1996).

The aforementioned studies regarding the late talkers' phonetic development and its relationship with lexical development are of potential clinical value. However, they focused only on English-speaking children. There are no similar studies for Cantonese-speaking late-talkers. The Cantonese phonological system differs from English on some aspects that make the above

findings inapplicable to Cantonese. First, the phonotactic structure in Cantonese is relatively simple. The syllable structure of Cantonese ranges from one to four segments with a vowel being an obligatory segment. There are six possible syllable structures including V, C, VC, CV, CVC and CVV (So & Dodd, 1992). The relatively simpler syllable structures may make vocabulary acquisition easier in Cantonese. Second, the phonetic inventory size in Cantonese is smaller than that of English. There are only 19 initial consonants and 6 final consonants in Cantonese (Appendix A). It may make the relationship between phonetic inventory size and lexicon size not as strong as that found in English. Lastly, Cantonese is a tonal language; different words can be differentiated by different tones even with the same phonetic component. Thus, the correlation between phonetic inventory size in terms of segments and lexicon size may not be as strong as that found in English due to the tone effect. To sum up, it is essential to explore the above issues in Cantonese-speaking late talkers. By investigating late talkers' phonetic development and its relationship with lexical size, clinicians can gain insights on the diagnosis and intervention of the late talkers, which are of potential clinical value.

Besides the current phonetic and lexical development of the late talkers, their language outcomes are also controversial. Since there is a great deal of variability in early language development, late talkers may have different language outcomes when they grow up even though they have similar starting language level. They may move into normal range of language development and become late bloomers or they may remain delayed and will be labeled as truly delayed late talkers. Many studies have investigated on this aspect of the late talkers. Consistent findings are found on the lexical development of the late talkers. Most of the studies suggest that late talkers are able to catch up into normal range in terms of expressive vocabulary size. For example, nearly 80% of the late talkers caught up in expressive vocabulary size in the studies of Rescorla, Roberts and Dahlsgaard (1997) while all late talkers did so in the studies of Weismer, Murray-Branch and Miller (1994).

However, inconsistent findings are found for the syntactic development of the late talkers. Rescorla and his colleagues (Rescorla & Schwartz, 1990; Rescorla et al., 1997) claim that even though the late talkers make rapid improvement in the area of lexical development, they may still demonstrate persistent delay in morphology and syntax. They found that less than a half of the late talkers diagnosed at 2 years old had MLU within normal range at age 3 follow up. However, Thal, Tobias and Morrison (1991) make an opposite claim. 60% of the late talkers were able to catch up in syntactic development in their studies.

For other outcomes such as academic and social abilities of the late talkers, two kinds of claim have been found in literature. Some claim that late talkers grow up with poor articulation skills (Paul, 1993) and narrative skills (Weismer et al., 1994) and are at risk for persistent language learning problems, academic and social difficulties (Paul & Jennings, 1992). Others claim that late talkers can catch up in terms of their language ability with their peers during preschool years and are indistinguishable from their age-matched peers in language ability, academic achievement and behavioral adjustment (Whitehurst, Smith, Fischel, Arnold, & Lonigan, 1991).

As the late talkers are found to vary widely in their language outcomes, researchers has made attempt to determine reliable predictors of their language outcomes in order to identify characteristics that can be indicative of late bloomers versus those that signal persistent language delay. A number of predictors have been proposed in the published literature. However, disagreement is found in some predictors among studies. Here are some examples. First of all, Thal et al., (1991) propose that receptive language ability at intake is a significant predictor of the late talkers' language outcomes on the areas of expressive vocabulary size and MLU. However, Weismer et al., (1994) and Rescorla et al., (1997) found an opposite result. The differences of the result may be due to different criteria used for the selection of the late talkers. In Thal et al.'s studies (1991), 40% of the late talkers exhibited significant receptive language delay whereas all late talkers had normal receptive language in the latter two studies. As the late

talkers' receptive language performance at intake is different, the prognostic value of receptive language ability may be affected. Second, the prognostic value of expressive vocabulary size at intake is also controversial. Both Thal et al., (1991) and Weismer et al., (1994) suggest that vocabulary size at intake cannot provide any prognostic information on the future lexical development of the late talkers. However, positive result was found in the studies of Whitehurst et al., (1991). The variance may be due to the use of different measuring instruments. In the former two studies, expressive language outcome was measured via parental report whereas in the later one, standardized expressive vocabulary test was used. Third, both Paul (1993) and Rescorla & Schwartz (1990) indicate that age of intake is a significant predictor of the late talker's syntactic development. However, the result of the studies of Rescorla et al., (1997) does not agree with this claim. Consistent findings on the predictors across studies are also noted. For example, to predict the late talkers' lexical and syntactic development, degree of expressive language delay relative to age expectations was found to be a significant predictor (Rescorla & Schwartz, 1990; Rescorla, et al. 1997) but MLU is not (Thal et al., 1991; Paul, 1993). There are some other predictors such as the proportion of consonant to vowel in vocalizations (Whitehurst et al., 1991), communicative gesture production (Thal et al., 1991) and gender (Paul, 1993).

It can be seen that the prognostic values of the information collected at intake vary among studies and depend on the way of identification of late talkers and outcomes measurement tools used. Thus, it is worth investigating the prognostic values of the reported predictors again by keeping other variables constant. Knowing the prognostic value of the information collected at intake can help clinicians to collect an informative case history and administrate a comprehensive direct assessment. When a toddler with slow language development shows significant predictive factors, earlier and intervention can be provided for him.

AIMS OF THE PRESENT STUDY

The present study focused on two controversial issues of late talkers. In Part I, it aimed at

exploring the phonetic development and the relationship between phonetic inventory and lexical size in Cantonese-speaking late talkers. The results can give clinicians insights on the development of the late talkers, aid diagnosis and intervention planning for them. To do so, two groups of late talkers (truly delayed and developing) and one group of late bloomers; representing different stages of lexical development were involved. Three global measures of phonetic development: size and complexity of phonetic inventory and accuracy of production of three groups of toddlers were compared with the data in the literature to determine whether the late talkers show a slowed-down version of normal development (phonological delay) or a different pattern of acquisition (phonological deviance) and to determine whether the late bloomers can catch up in phonetic development along with lexical development.

In Part II, the focus of this study was extended to the late talkers' productive language outcomes and the corresponding predictors. It aimed at exploring the productive lexical development of the late talkers one year later, expressive vocabulary size measured by CCDI was taken as the outcome measure of the late talkers. The proportion of the late talkers that grew into truly delayed late talkers, developing late talkers and late bloomers would be determined. In addition, predictive value of the expressive language ability at intake on the late talkers' productive lexical outcome was re-evaluated in this study. A new predictor, age of first word was also investigated in this study as no study has worked on it. It was worth investigating, as age of first word is an important sign for clinician to determine whether the child's language development is normal or not. It is believed that if the child produces his first word abnormally late, his expressive language development is not favorable.

METHOD

Intake Instruments

The Cantonese version of MacArthur Communicative Development Inventories (CCDI) (Tardif, Fletcher, Leung, C. S. & Leung, S. L., in prep.) is a series of parent report instruments for assessing language and communication skills in infants and young children. CCDI has good

concurrent validity in relation to the Cantonese version of Reynell Development Language Scale. Also, its test-retest reliability is high. Thus, it is a reliable and valid tool for identifying children with expressive language delay. CCDI has two sets of forms: CCDI: infant (Word and Gesture) is designated for use with 8 to 16 month-old children and CCDI: toddler (Word and Sentence) is designed for use with 16 to 30 month-old children.

Only the Word part in both forms was involved in this study. CCDI: infant consists of a 389 vocabularies checklist organized into 19 semantic categories. Parents were asked to mark which words the child can understand and which words the child can say. CCDI: toddler composes of a 804 productive vocabulary checklist organized into 24 semantic categories. Parents were asked to mark only those words the child can say.

Background Information of the CCDI Project

In summer 2001, 1625 children aged between 8 and 30 months, with up to 66 participants in each age group, were recruited from five Maternal and Child Health Centres in Hong Kong to join the norming study of CCDI. All of them were reported to have no significant birth history, family history of speech and language impairment, mental retardation and neurological impairment. The receptive language ability of these children was reported to be normal by the parents. The parents were asked some basic information about the child including background information and developmental history. They were then asked to complete the CCDI corresponding to their child's age. The reported vocabulary size of the children was ranked. Those scored in the lowest 10^{th} percentile (original late talkers, OLTs), medium 50^{th} percentile and the top 10^{th} percentile for their age were invited to take part in the follow-up study in summer 2002.

309 children, aged between 18 and 33 months joined the follow-up study. In the follow-up study, the short form of CCDI: toddler was used. It comprises of a checklist of only 135 representative words (sélected from the long form). Thus, it can serve as an alternative to the long form for rapid assessment of a child's expressive language level. The reported vocabulary

size of the children was ranked. The original late talkers (OLT) who scored in the lowest 10th percentile, 25th percentile and above 50th percentile were labeled as truly delayed late talkers (LTt), developing late talkers (LTd) and late bloomers (LB) respectively. A picture-naming task was carried out to elicit the child's speech at the same time. In the picture-naming task, the children were asked to name 55 pictures. The words were chosen to ensure the elicitation of three productions of each initial phoneme in Cantonese (except phoneme /kw^h/, which appears only once in the target pictures). The target words were either monosyllabic or disyllabic.

Subjects

Subjects for Part I were 11 children from each of the LTt, LTd and LB groups while subjects for Part II *were* 55 original late talkers (OLTs). All of the subjects were 15 to 20 month-old at intake and 27 to 32 month-old at follow-up. This age range was selected because children were likely to be at the onset of vocabulary development at intake and experience the vocabulary spurt during the year before the follow up (Ingram, 1989). Also, rapid phonological development is expected to occur at from one to three years (Bernthal & Bankson, 1998).

Procedure

The language samples collected in the picture-naming task were transcribed first by the author using the International Phonetic Alphabet. Ten percent of the data was transcribed by another undergraduate student trained in phonetics to evaluate the inter-rater reliability. Another 10% of the data were re-transcribed by the author one month after the first transcription to determine the intra-rater reliability. Point-to point intra-rater reliability and inter-rater reliability on the initial consonants were 97.3% and 94.2% respectively.

Data Analysis

Prior to the data analysis, test was conducted to determine whether the groups at one-year follow up were significantly different in the lexical development. The reported vocabulary size, as measured in the short form of CCDI was counted for each subject and the average size was computed for each group. Group differences on the reported vocabulary size were examined

using a one-way ANVOA to determine if the lexical development was significantly different among groups. Post hoc tests (Tukey $p<0.05$) used for mean differences were applied in the case of significant main effects.

After the lexical development of three groups of toddlers was verified to be significantly different, the following data analysis was done.

Part I

Relationship Between Lexical Size and Phonetic Inventory Size:

Phonetic inventory size. The different number of phones in the child's phonetic inventory was regarded as phonetic inventory size. The child was credited with having a phone in his phonetic inventory if it appeared twice or more times in the child's spontaneous speech, regardless of the accuracy of the production (Stoel-Gammon, 1985). The number of phones appeared in the inventory was counted for each subject and the mean number of phones was computed for each group. Group differences on phonetic inventory size were examined using a one-way ANVOA to determine if the phonetic inventory size among groups was significantly different. Post hoc tests (Tukey $p<0.05$) used for mean differences were applied in the case of significant main effects. In this study, only initial consonants were tallied. Although there are 19 initial consonants in Cantonese, only 16 phonemes were considered in this study. The phonemes /n-/ and /l-/ were excluded because there is a trend of producing the phoneme /n-/ as phoneme /l-/ (Zee, 1991) and merging the phoneme /ŋ-/ with zero-initial (Yip, 1997) in Cantonese. Cluster /kw^h/ was also excluded due to the low frequency of occurrence in the target pictures.

Relationship between phonetic and lexical sizes. After the lexical and phonetic inventory sizes of each subject was calculated, the relationship between the two variables was investigated for each group with Pearson correlations test.

Phonetic Development of the Late Talkers and Late Bloomers

Complexity of phonetic inventory. The number of phones present in more than 50% of the subjects' inventories (n ≥6) was counted, by group. Also, phones in the phonetic inventory of each group were grouped into classes corresponding to the developmental acquisition order (based on a criterion of 90% correct production in spontaneous language samples by Cantonese-speaking children aged between 2;0 to 6;0 in the studies of So & Dodd (1995)). By this method, early developing sounds identified were unaspirated front stops (/p/ and /t/), nasal (/m/) and glides (/w/, /j/, /h/*); middle developing sounds were unaspirated velar stop (/k/), aspirated stops (/p^h/, /t^h/, /k^h/), cluster (/kw/) and liquid (/l/); and late developing sounds were fricatives (/f/, /s/) and affricates (/ts/, /ts^h/). The phonetic inventory of each group was then compared with the developmental acquisition order.

Accuracy of production. The percentage of consonants correct (PCC) relative to the adult target word was used to measure the accuracy of production of the child. PCC of each subject was calculated and the average value was computed for each group. Group differences on PCC were investigated using one-way ANOVA. Post-hoc test (Tukey, $p<0.05$) was used to indicate where the significant differences came from.

Part II

Productive Language Outcome of the Late Talkers

Among those 55 original late talkers (OLT), the number of children who developed into late bloomers (LB), developing late talkers (LTd) and truly delayed late talkers (LTt) at one year follow up was counted according to their percentile rank of vocabulary size measured in the short form CCDI.

*According to Chomsky & Halle (1968), phoneme /h/ is considered to be a glide rather than a fricative due to the absence of constriction of airflow in the articulators during production.

Predictors of the Late Talkers' Language Outcome

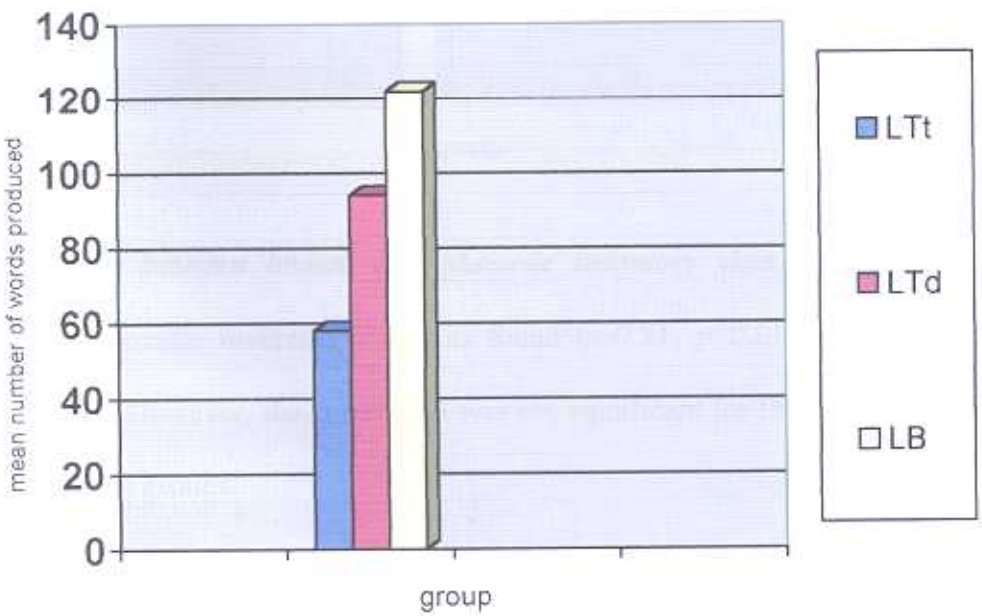
Correlation between the possible predictors (age of first word and the reported vocabulary size at intake) and the language outcome at one-year follow up (the reported vocabulary size) was investigated using Pearson correlations test. If positive correlation was found, they could be claimed as significant predictors of the late talkers' productive lexical language outcomes.

RESULTS

Prior Test on the Lexical Measures of the Three Groups of Toddlers

The mean number of the reported words produced in the LTt group, LTd group and LB group was 57.9 (SD=23.47), 94.09 (SD=8.18) and 121.63 (SD=9.53) respectively (See Fig 1). A one-way ANOVA comparing the lexical size for three groups showed a main effect for groups, $F(2, 30) = 47.583$, $p<0.001$. Post-hoc comparisons (Tukey, $p<0.01$) indicated that the late bloomers had significantly larger lexicon size than the other two groups of late talkers. Within the two groups of late talkers, developing late talkers had significantly larger lexicon size than that of the truly delayed later talkers.

Figure 1. Mean number of words produced for the three groups of children

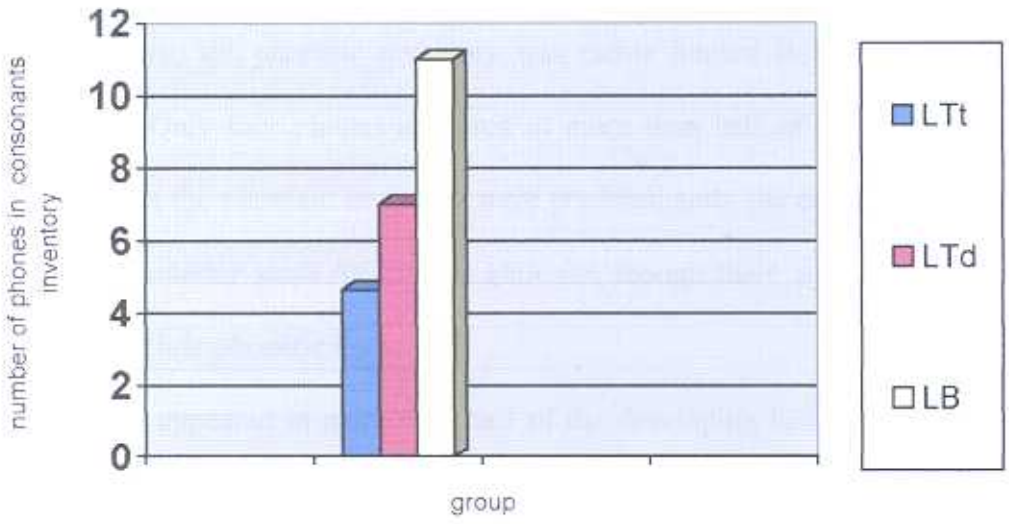


Part 1:

Relationship Between Lexical Size and Phonetic Inventory Size:

Phonetic measures. The mean number of phones in the phonetic inventories for LTt group, LTd group and LB group was 4.63 (SD=2.20), 7 (SD=1.41) and 11 (SD=2.65) (See Fig 2). The mean number of phones in the inventories increased substantially from LTt group to LB group. A one-way ANOVA comparing the phonetic inventory size for three groups showed a main effect for group, $F(2, 30) = 22.07$ ($p<0.001$). Post-hoc comparisons (Tukey, $p<0.01$) indicated that the late bloomers produced significantly more different types of consonants than the two groups of late talkers. Within the two groups of late talkers, developing late talkers had significantly larger consonant inventory than that of the truly delayed late talkers.

Figure 2. Mean initial consonant inventory for the three groups of children



Relationship between lexical and phonetic inventory sizes. Strong correlation on lexicon size and phonetic inventory size was found ($r=0.81$, $p<0.01$) in the group of truly delayed late talkers. However, the correlation was not significant for the developing late talkers and the late bloomers groups.

Phonetic Development of the Late Talkers and Late Bloomers

Complexity of the phonetic inventory. The phonetic inventories were analyzed for each group and tabulated in Table 1:

Table 1: Phones present in 50% of the subjects' inventories in the three groups

	Developmental sequences	Phones in inventories of 50% of subjects	Phones missing in the inventories of subjects
LTt	Early:	p, t, h	m, w, j
	Middle:		k, l, kw, p^h, t^h, k^h
	Late:	f	s, ts, ts^h
LTd	Early:	p, t, h, **m, j,**	W
	Middle:	**k**	l, kw, p^h, t^h, k^h
	Late:	f	s, ts, ts^h
LB	Early:	p, t, h, m, **w**, j	
	Middle:	**p^h, t^h,** k, **k^h, l**	Kw
	Late:	f, **s, ts, ts^h**	

***Bold phonemes** = the additional phones compared with the above group

As can be seen, the phonetic inventory was rather limited in the group of the truly delayed late talkers. Only four phones appeared in more than half of the truly delayed later talkers. The phones in the phonetic inventory were predominantly the early developing sounds such as unaspirated anterior stops /p/, /t/ and glide /h/, though there was one late developing sound, fricative /f/ in their phonetic inventory.

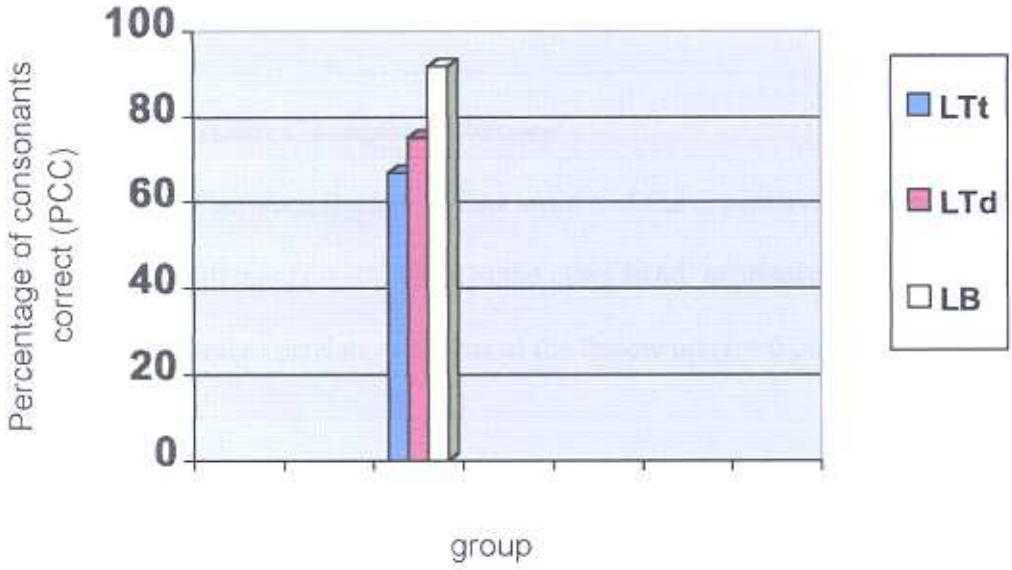
Seven phones appeared in more than half of the developing late talkers. Although the developing late talkers had more complex phonetic inventory, the distribution of consonant types was similar to the truly delayed late talkers. The developing late talkers nearly acquired all of the early-developing sounds (except glide /w/) and middle developing sound started to emerge in their phonetic inventory.

For the late bloomers, 15 phones appeared in more than half of the late bloomers. Their phonetic inventory was nearly completed. The majority of the late bloomers produced essentially the full range of consonant types except for the cluster /kw/.

On the other hand, the order of appearance of phones was relatively constant across three groups. It was generally from unaspirated anterior (labial and alveolar) stops /p/ and /t/, followed by the unaspirated velar stops /k/, the nasal /m/ and the glide /l/ to the affricates and the aspirated stops (anterior and velar) down the groups. Except the early appearance of the late developing sound, fricative /f/, such order of appearance of phones was similar to the developmental acquisition order stated in the studies of So & Dodd (1995).

Accuracy of production. The average percentage of consonants correct (PCC) for the LTt group, LTd group and LB group was 66.6 (SD=11.5), 74.7 (SD=12.7) and 91.8 (SD=6.6) respectively (See Fig 3). PCC scores of developing late talkers were slightly higher than that of the truly delayed late talkers. However, the scores increased dramatically in the late bloomers group. A one-way ANOVA comparing PCC scores for the three groups showed a main effect for group, $F(2, 30) = 16.126$, $p<0.005$. Post-hoc comparisons (Tukey, $p<0.01$) indicated that the late bloomers produced significantly more consonants correct than that of the two groups of late talkers. Within the two groups of late talkers, developing late talkers did not differ significantly from the truly delayed later talkers in PCC.

Figure 3: Percentage of consonants correct (PCC) of the three groups

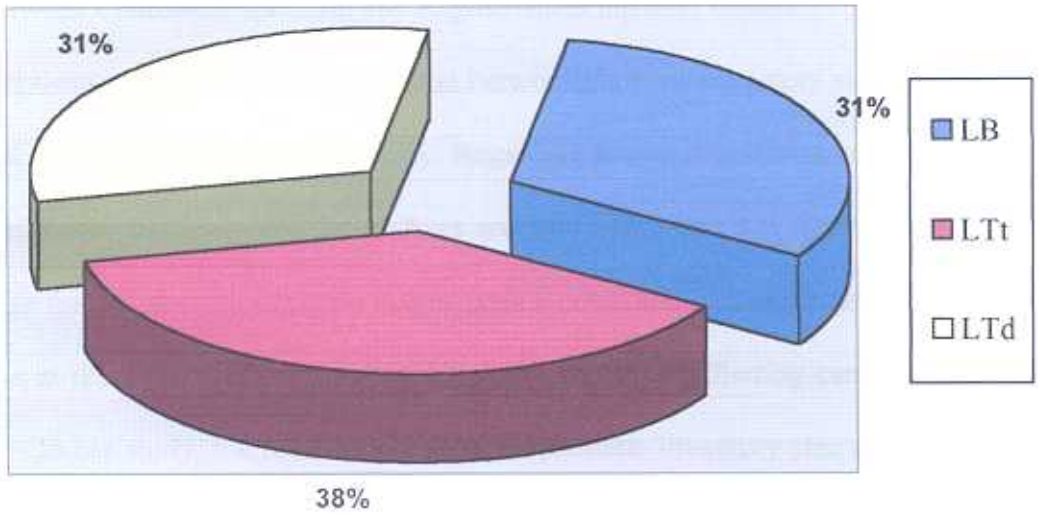


Part II:

Language Outcome of Late Talkers

Among the 55 original late talkers (OLT), 38 % (n=21) of them grew out of the delay in expressive vocabulary size and became late bloomers (LB). The remainders continued to show delay in their expressive lexical development. For the remainders, half of them (n=17) showed improvement in their lexical development (LTd) whereas half of them (n=17) remained delayed on follow up (LTt). (See Fig 4)

Figure 4. Language outcome of the late talkers (OLT) at one-year follow up



Predictors of the Late Talkers' Language Outcome

The correlation between the age of first word and the expressive vocabulary size at follow up was not significant (r = -0.163). On the other hand, expressive vocabulary size at intake did not significantly correlate with that at the follow up (r = 0.209).

DISCUSSION

Relationship Between Lexical Size and Phonetic Inventory Size of the Late Talkers

As seen in the results, correlation between the size of the phonetic inventory and lexicon size was high and significant for truly delayed later talkers. It indicates that the number of phones a child has will affect, or be affected by the overall amount of lexical production. Children with a less complete phonetic repertoire have a smaller vocabulary size and vice versa. The result of this study was consistent with those found in Paul and Jennings (1992), Thal et al., (1995) and Rescorla and Ratner (1996): children who demonstrate delayed expressive development show deficits in phonetic development also. Thus, no cross-language differences are noted between Cantonese-speaking and English-speaking later talkers.

Apart from a positive correlation found between phonetic inventory size and lexical size, an additional finding was noted in this study. Regarding the nonsignificant relationship of these two variables found in developing late talkers and late bloomers, it is likely that the phonetic inventory size for initial consonants no longer pose a constraint on the vocabulary development or vice versa at the late stage of language development. Similar finding can be found in Ma's (2002) study. In her study, the relationship between phonetic inventory size and the lexical size in normally developing children was explored longitudinally for six months. The result indicated that the relationship between the two variables was significantly correlated at the young age (16 months). However, the correlation failed to attain a significant level at the following data point (19 and 22 months). Therefore, Ma (2002) concludes that the relationship between the lexical and phonetic inventory size is strongest at the young age but the relationship weakens, when the child grows older.

Two hypotheses are drawn to explain the weakening of the relationship between lexical size and phonetic inventory size at the later stage of development. First of all, it is hypothesized that once the phonetic inventory reaches a certain level, it no longer poses any constraints on the lexical development. According to Stoel-Gammon (1998), children must eventually attempt to

produce words with phonetic features beyond their capability if they were to acquire new words. As the phonetic inventories expand to a certain size (as in the developing late talkers group and the late bloomers group) so that the child has enough raw materials or enough vocal practice to attempt a word, any limitation on phonetic inventories do not seem to have any influences on the acquisition of words. Stoel-Gammon (1998) also claims that the influences of lexical selection on vocabulary acquisition decline beyond the first 50-word period. It is because a child's articulatory capabilities increase and the basic syllable shapes and sounds classes develop, he is capable of making any attempt to produce a word. The child's phonological system, though far from complete, does not limit acquisition of lexicon anymore.

The other hypothesis is just the opposite of the first one. It is hypothesized that once the lexical size reaches a certain level, it no longer constrains the phonetic inventory development. Interactionist-discovery theory (Menn, 1980, cited in Girolametto et al., 1997) states that children discover the rules of phonology through lexical learning and rich language exposure. As the lexical size of the child expands to a certain size that the child gets known to most of the sound classes, any expansion of the lexical size is not likely to affect the phonetic inventory size.

To conclude, lexical size goes hand in hand with the phonetic inventory size only at the preliminary stage of the late talkers' lexical and phonetic development. Once the phonetic inventory and lexical size reaches a certain level, the lexical development and phonetic development goes independently.

Phonetic Development of the Late Talkers

Comparison of the language samples among truly delayed late talkers, developing late talkers and late bloomers revealed striking differences in their phonetic development. Most of the results reported in this study were consistent with the findings of Paul and Jennings (1992) and Stoel-Gammon (1989). Moreover, this study extended previous findings by providing an additional analyse of the phonetic development for a group of developing late talkers. It

demonstrated that the late talkers were able to improve their phonetic ability concurrently with the lexical ability, even though they failed to catch up with the normal developing counterparts. Also, by introducing a group of developing late talkers as a middle stage of the late talkers' development, the phonetic development of the late talkers could be tracked more thoroughly.

Size of the Phonetic Inventory

The truly delayed and the developing late talkers had significantly smaller size of phonetic inventory than the late bloomers. It indicated that the phonetic development of the two groups of late talkers were slower. Within these two groups, developing late talkers had relatively larger size of phonetic inventory than truly delayed late talkers. It suggested that the phonetic skill of the developing late talkers improved along with their improvement in lexical skills, although the improvement of the two domains were not correlated significantly as aforementioned. For the late bloomers, their phonetic inventory size was within the normal limit. According to Mak (2002), the phonetic inventory size of normally developing toddlers aged at 27 months and 30 months should be 11.2 (ranged from 9-13) and 12.3 (ranged from 11-14) respectively. Therefore, the appropriate phonetic size found in late bloomers suggested that they were not only able to catch up in lexical size, but also the phonetic inventory size.

Complexity of the Phonetic Inventory

The initial consonant appeared in the phonetic inventory of 50% of the subjects were consistent across groups and the pattern of the acquisition of initial consonants of the three groups was found to follow the normal developmental acquisition order of phonemes cited in literature. It suggested that the pattern of the phonetic development of the late talkers is delay rather deviant. That is, phones likely to appear in late talkers' inventories are those typically acquired earliest by normal children.

However, there were two pieces of evidence that conflict with the above claim. First, the late developing sound, fricative /f/ appeared unusually early in the inventory of the truly delayed late talkers. Second, the middle developing sound: cluster /kw/ did not show up in the inventory of the late bloomers in which all of the late developing sounds had been acquired.

For the first phenomena, there are two possible explanations. The most likely explanation is that the early appearance of this sound is an artefact of the content of the naming task, which included as target /f/ words used (/fan$_6$/ 'rice', /fa1/ 'flower', /fei1 kei1/ 'aeroplane') in the picture-naming task was relatively more familiar to the child, the spontaneity of the child's production of it increased. The second explanation is related to its place features. Although sound /f/ is a fricative sound which is supposed to be acquired at the later stage of development, it is a labial sound, which is the place feature that the child acquired early. So, it increases the child's ease of acquiring such kind of fricative.

The absence of the cluster /kw/, even in the inventory of the late bloomers group might be attributed to the content of the naming task again. As the target /kw/ words included (/kwai$_2$ sɐu$_3$/ 'monster', /kwɐi$_6$ t^{h}ɔŋ$_2$/ 'drawer', /kwɐn$_2$/ 'stick') in the picture-naming task was unfamiliar to the child, the spontaneity of the child's production reduced.

Accuracy of Production

The results indicated that the truly delayed late talkers and the developing late talkers had similar PCC scores while late bloomers had significantly higher scores. For the relatively low accuracy of the production of the truly delayed late talkers group, a possible explanation is because of their limited phonetic inventory size. Take the hypothesis proposed by Paul & Jennings (1992) that a limited phonetic inventory limits the child's ability to attempt words and hence, limited practice for his speech articulation skills. Therefore, his production may be less accurate. Although the developing late talkers had significantly greater phonetic inventory size

than that of the truly delayed late talkers, their skills of using the phonemes properly might be still immature. Thus, the PCC scores of the developing late talkers did not increase significantly. On the other hand, the significantly higher PCC scores of the late bloomers than the other two groups further suggested that the phonetic development of the late bloomers caught up along with the lexical development.

To summaries the above findings, the phonetic development determined in a one-year follow up study of the original late talkers (OLT) identified via CCDI varied. At the follow up, the groups of LTd and LTt were found to be less advanced in their phonetic skills, in terms of the size and complexity of the phonetic inventory as well as the accuracy of production than the group of LB. However, the LTd showed relatively more advanced phonetic skills, in terms of the size and complexity of the phonetic inventory than the LTt, regardless of their fair performance on production accuracy. It suggested that some of the late talkers had potential to improve their phonetic abilities, even though they were still not capable of developing into the normal limit. Also, the two groups of the late talkers (LTt and LTd) were found to have relatively smaller phonetic inventory size than the LB, and they followed the normal developmental order of consonant acquisition. It suggested that the pattern of the phonetic development of late talkers is delayed rather than deviant.

Regarding the phonetic development of the late bloomers, they were found to be able to catch up with normal age-mates for both lexical and phonetic development (in terms of size and complexity of phonetic inventory and accuracy of production). The results were consistent with that of Stoel-Gammon's studies (1989). The two late bloomers in her studies were also able to catch up in phonetic development concurrent with the lexical development beyond the age of 2, despite their limitations in both domains before.

Language Outcomes of the Late Talkers and Its Predictors

Following the lexical development of the late talkers can give information on their prognosis. In this study, it was found that nearly 2/3 of the original late talkers (OLT) continued to be delayed in single-word vocabulary after one year. The result was inconsistent with those studies found in the literature (Wesimer et al., 1994; Whitehurst et al., 1991). The literature indicates that a large proportion of late talkers is able to move into normal range of expressive vocabulary size at follow up. The difference is probably due to the age of identification of the late talkers. The late talkers in most of the published studies were identified at 24 months old or even older and their language performances were re-evaluated at or above 36 months. They were likely to experience a rapid vocabulary spurt during the time before follow-up. However, the original late talkers in this study were relatively young at intake (15–20 months). Some of them had their first word just emerged. Also, they might have just entered the period of vocabulary spurt at follow up. Thus, their vocabulary sized might just expand and had not yet caught up with the normal peers. As a result, only 1/3 of the original late talkers could catch up as late bloomers in lexical development at follow-up. However, the data indicates that another 1/3 of the OLT was developing in their lexical skills and significant improvement was noted even though they remained delayed. This group of developing late talkers is probably under a rapid vocabulary growth. They have potential to be late bloomers if more time is given, say at 36 months.

To conclude, late talkers had potential of catching up with their normally developing age-mates. However, it depends on both the individuals' ability and the environmental factors.

Unfortunately, no significant predictors were found in this study. The two possible predictors, age of first word and expressive vocabulary size at intake in this study were found to fail to predict the expressive vocabulary size at one-year follow-up. For the expressive vocabulary size at intake, the result is consistent with that found in the studies of Weismer et al.,

(1994). Weismer and his colleagues states that expressive vocabulary size at intake has no predictive value on the late talkers' lexical outcome. On the contrary, an inconsistent finding between this study and the studies of Whitehurst, et al., (1991) is noted. It is probably because different outcome measurement tools were employed, as aforementioned.

For the age of first word, no studies would be compared with this study as no similar studies have been done in the literature. However, it is supposed that first word is one of the developmental milestones. It can give clinicians insight on the child's language development. Thus, it is believed that it can predict the late talkers' language outcomes. However, the result showed that it is not the case. One of the reasons is that the age of first word was limited in range. Although the age range was between 6 and 17 months (n=12), a majority of late talkers (76%) had their first words between 10 and 15 months (n = 6). Therefore, the limited age range made the results nonsignificant. Another reason is that the age of first word of all the late talkers was within the normal age range. Thus, it is sensible that the normal lexical developmental milestones fail to predict the expressive language delay of the late talkers.

CONCLUSION

In this study, no cross-language difference on the relationship between the phonetic inventory size and the lexical size of late talkers was found. It was found that the relationship is strong and bi-directional at the early stage of development, but the relationship weakens at the later stage. Also, the late talkers were found to have delayed phonetic development, which was characterized by a restricted phonetic inventory size and reduced accuracy of production. On the other hand, the late talkers were also found to have different paths of lexical development. Although only one-third of the late talkers were able to catch up after one year in this study, another one-third of the late talkers was expected to be late bloomers soon. It was concluded that late talkers had potential to catch up with the normal developing toddlers in expressive

vocabulary development. However, age of first word and expressive language ability at intake failed to help clinicians to predict the late talkers' language outcome.

CLINICIAL IMPLICATION

The results presented in this study suggest several implications for clinicians. First, the relationship between lexical size and phonetic inventory size of late talkers found in this study can give clinician insight on the intervention for the late talkers at different stage. With the expectation that increases in lexicon size would also accelerate the emerging phonological development of late talkers at the early stage of development (say in the lowest 10^{th} percentile on vocabulary size), clinicians can target on vocabulary in order to expand the late talkers' phonetic inventory size. Clinicians can introduce the vocabulary with great variety of phonemes or with phoneme in different vowel contexts. However, when the child's lexical size expands to a higher level, say above the 25^{th} percentile, direct intervention on the particular areas should be provided as the lexical and phonetic development go independently at this stage. Second, the phonetic development of the late talkers is delayed rather than deviant. It suggests to the clinicians that sounds that are easy to produce for the normally developing children are those have greater potential for the child to acquire. Therefore, the clinicians can gain some hints on choosing an appropriate phoneme as treatment target.

LIMITATION

The present study has several limitations. First, no standardized receptive language tests were administrated to ensure the normal receptive language of the late talkers even though the subjects were reported to have normal receptive language ability. Second, only picture-naming task was used to assess the late talkers' phonetic development. Although the naming task has an advantage of increasing the intelligibility of the child's sample, as the target of the child's production is known (Paul & Jennings, 1992). It may not be able to provide information of syllable shapes, consonant inventories and syllable position of consonants (Stoel-Gammon,

1989). Also, the use of a picture-naming task with young children may not reflect the manner in which they produce words in naturalistic interaction. Moreover, no data on MLU or grammatical development are available for the late talkers (Paul & Jennings, 1992). Therefore, the investigation on the late talkers' phonetic development might not be comprehensive enough.

FURTHER STUDIES

Although the relationship between the late talker's lexical size and their phonetic development was identified in this study, it is difficult to determine which one is the causal factor. Thus, further investigation on the direction of the link is necessary so as to provide greater clinical implications. Experimental study of the effect of lexical or phonological intervention on later talkers' development in both domains is suggested. It is to determine whether different treatment approaches could lead to different outcomes. As a result, the influence of lexical expansion on phonological acquisition and vice versa would be verified. Moreover, the other studies show that even if the vocabulary size of the late talkers has caught up with their peers; they may still demonstrate productive deficits in other areas such as syntactic and narrative skills (Paul, 1991). Thus, investigation on other aspects of language development should be conducted so as to get a whole picture on the Cantonese-speaking late talkers' language outcomes.

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Appendix A

The inventory of initial consonants in Cantonese

Manner of articulators	Place of articulators					
	Bilabial	Labial dental	Alveolar	Palatal	Velar	Glottal
Plosives	p p^h		t t^h		k k^h kw kw^h	
Nasal	m					
Fricative		f	s			
Affricate			ts ts^h			
Approximant	w		l	j		h

The inventory of final consonants in Cantonese

Manner of articulators	Place of articulators					
	Bilabial	Labial dental	Alveolar	Palatal	Velar	Glottal
Plosives	-p		-t		-k	
Nasal	-m		-n		-ŋ	

Appendix B

Profiles of the late talkers: truly delayed

Subject ID	Sex	Age at follow-up	CCDI long forms taken	Total "Can say" words in long form (Vocabulary size)	Total "Can say" words in short form (Vocabulary size)	Percentile rank in "Can say" in short form	Number of phones in phonetic inventory	PCC
22119207	F	30	Toddler	6	22	5	1	49
22119101	M	30	Toddler	8	32	5	2	66
22420126	M	31	Toddler	6	34	5	3	57
22217215	F	29	Toddler	2	36	5	4	75
12314208	F	27	Infant	10	58	10	5	51
22218115	M	30	Toddler	0	63	10	5	80
22117204	F	28	Toddler	2	68	10	4	58
22318109	M	30	Toddler	7	72	10	8	66
12516123	M	28	Infant	9	78	10	6	82
22420236	F	32	Toddler	42	81	10	8	74
22220217	F	32	Toddler	13	93	10	5	75

Profiles of the late talkers: developing

Subject ID	Sex	Age at follow-up	CCDI long forms taken	Total "Can say" words in long form (Vocabulary size)	Total "Can say" words in short form (Vocabulary size)	Percentile rank in "Can say" in short form	Number of phones in phonetic inventory	PCC
12516222	F	27	Infant	10	82	25	7	66
22220118	M	32	Toddler	18	83	25	7	77
22516120	M	28	Toddler	2	87	25	5	50
22520123	M	32	Toddler	12	88	25	7	74
22219211	F	31	Toddler	16	95	25	6	67
12216113	M	28	Infant	29	96	25	6	89
22118203	F	30	Toddler	7	96	25	7	90
22516221	F	27	Toddler	5	98	25	6	83
22319209	F	32	Toddler	5	101	25	7	83
22417128	M	29	Toddler	7	101	25	9	60
22418123	M	30	Toddler	0	108	25	10	83

Profiles of the late bloomers

Subject ID	Sex	Age at follow-up	CCDI long forms taken	Total "Can say" words in long form (Vocabulary size)	Total "Can say" words in short form (Vocabulary size)	Percentile rank in "Can say" in short form	Number of phones in phonetic inventory	PCC
22120205	F	31	Toddler	34	108	50	9	92
12116204	F	28	Infant	6	112	50	8	94
22419133	M	31	Toddler	3	113	50	7	100
22520121	M	32	Toddler	8	114	50	13	96
22218111	M	31	Toddler	8	116	50	14	98
12315212	F	27	Infant	4	122	90	9	83
12416128	M	27	Infant	53	125	90	10	80
12315209	F	27	Infant	15	128	95	13	98
12515221	F	27	Infant	13	132	95	14	94
22217117	M	27	Toddler	7	134	95	10	90
22518120	M	29	Toddler	6	134	95	14	85

Appendix C

Phonetic inventory of the subjects in the group of truly delayed late talkers

Manner of articulators	Place of articulators					
	Bilabial	Labial dental	Alveolar	Palatal	Velar	Glottal
Plosives	**p** (8) p^h (3)		**t** (7) t^h (1)		k (3) k^h (1) kw (0) kw^h	
Nasal	m (3)					
Fricative		**f** (6)	s (1)			
Affricate			ts (3) ts^h (2)			
Approximant	w (2)		l (0)	j (4)		**h** (7)

( ) = number of subjects present the phonemes in his/her phonetic inventory
* bold phonemes = phonemes present in 50% of the subjects' inventory

Phonetic inventory of the subjects in the group of developing late talkers

Manner of articulators	Place of articulators					
	Bilabial	Labial dental	Alveolar	Palatal	Velar	Glottal
Plosives	**p** (9) p^h (4)		**t** (11) t^h (4)		**k** (6) k^h (1) kw (0) kw^h	
Nasal	**m** (6)					
Fricative		**f** (7)	s (2)			
Affricate			ts (4) ts^h (5)			
Approximant	w (3)		l (2)	**j** (7)		**h** (6)

( ) = number of subjects present the phonemes in his/her phonetic inventory
* bold phonemes = phonemes present in 50% of the subjects' inventory

Phonetic inventory of the subjects in the group of late bloomers

Manner of articulators	Place of articulators					
	Bilabial	Labial dental	Alveolar	Palatal	Velar	Glottal
Plosives	**p** (11) **p^h** (7)		**t** (10) **t^h** (6)		**k** (8) **k^h** (6) kw (1) kw^h	
Nasal	**m** (8)					
Fricative		**f** (11)	**s** (8)			
Affricate			**ts** (10) **ts^h** (9)			
Approximant	**w** (9)		**l** (6)	**j** (8)		**h** (8)

( ) = number of subjects present the phonemes in his/her phonetic inventory
* bold phonemes = phonemes present in 50% of the subjects' inventory

Appendix D

Profiles of all subjects involved in Part II of the study

Subject ID	Sex	CCDI long form taken	Age at follow up	Age of first word	Vocabulary size at intake as measured by CCDI long form	Vocabulary size at follow-up as measured by CCDI short form	Percentile rank of "Can Say" words in short form
22116202	F	Toddler	28	12	7	60	5
22217215	F	Toddler	29	16	2	36	5
22119207	F	Toddler	30	15	6	22	5
22117201	F	Toddler	28	14	7	62	5
12115103	M	Infant	29	14	5	20	5
22117104	M	Toddler	30	6	6	22	5
22119101	M	Toddler	30	12	8	32	5
22420126	M	Toddler	31	15	6	34	5
12114103	M	Infant	27	13	5	18	10
12314208	F	Infant	27	10	10	58	10
22116103	M	Toddler	28	14	9	64	10
22117204	F	Toddler	28	12	2	68	10
12516123	M	Infant	28	12	9	78	10
22117107	M	Toddler	29	10	8	77	10
22419132	M	Toddler	30	14	7	58	10
22218115	M	Toddler	30	--	0	63	10
22318109	M	Toddler	30	12	7	72	10
22419227	F	Toddler	31	12	16	71	10
22519126	M	Toddler	31	8	9	79	10

22419133	M	Toddler	31	17	3	113	50
22218111	M	Toddler	31	10	8	116	50
22520121	M	Toddler	32	17	8	114	50
12215210	F	Infant	27	13	1	119	90
12315212	F	Infant	27	14	4	122	90
12416128	M	Infant	27	11	53	125	90
12315209	F	Infant	27	6	15	128	95
12515221	F	Infant	27	10	13	132	95
22217117	M	Toddler	27	12	7	134	95
22518120	M	Toddler	29	12	6	134	95

22420236	F	Toddler	32	9	42	81	10
22220217	F	Toddler	32	14	13	93	10
12116106	M	Infant	27	11	6	43	25
12416133	M	Infant	27	12	16	68	25
12516222	F	Infant	27	--	10	82	25
22116201	F	Toddler	27	12	4	88	25
12416226	F	Infant	27	10	60	97	25
22516221	F	Toddler	27	12	5	98	25
22516120	M	Toddler	28	15	2	87	25
12216113	M	Infant	28	--	29	96	25
22117206	F	Toddler	28	12	10	97	25
22417128	M	Toddler	29	9	7	101	25
22218137	M	Toddler	30	16	7	91	25
22118203	F	Toddler	30	14	7	96	25
22418123	M	Toddler	30	--	0	108	25
22219211	F	Toddler	31	11	16	95	25
22220118	M	Toddler	32	15	18	83	25
22520123	M	Toddler	32	13	12	88	25
22319209	F	Toddler	32	14	5	101	25
12515121	M	Infant	27	--	0	76	50
12115105	M	Infant	27	14	3	78	50
12116204	F	Infant	28	9	6	112	50
22517219	F	Toddler	29	6	11	105	50
22119103	M	Toddler	30	8	7	109	50
22518226	F	Toddler	30	12	7	114	50
22120205	F	Toddler	31	13	34	108	50